Learned Vertex Descent: A New Direction for 3D Human Model Fitting

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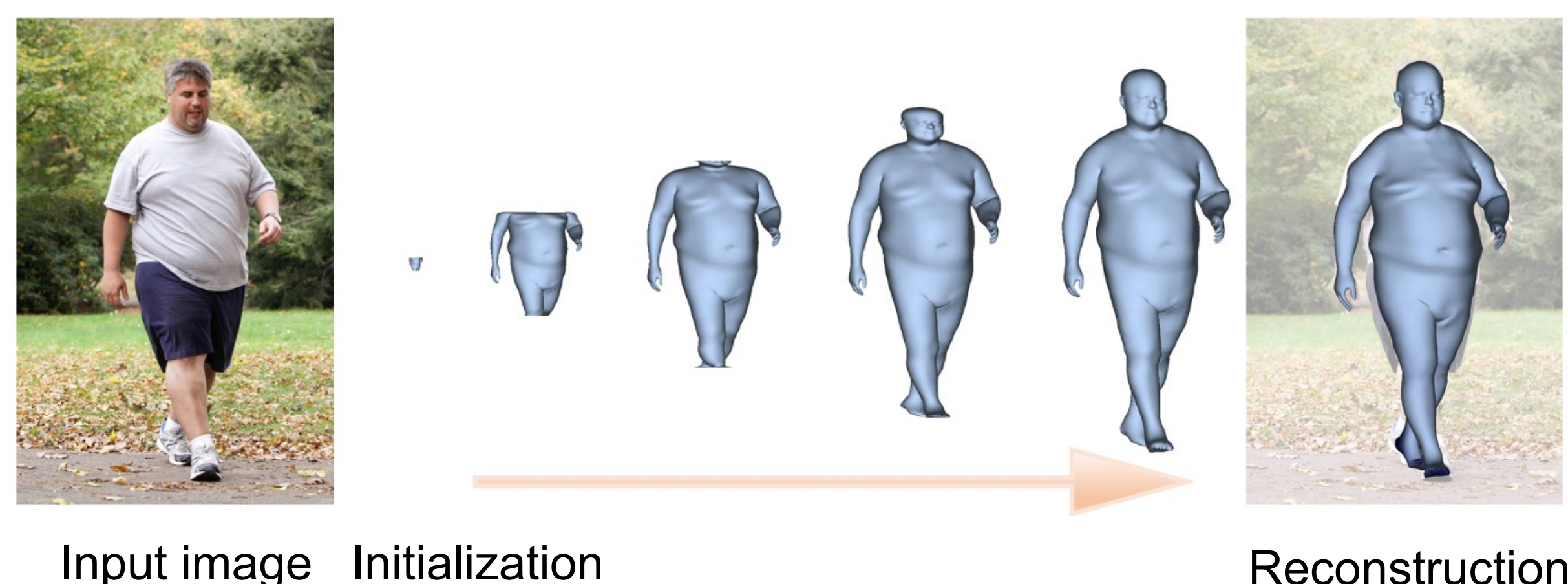[3]Max Planck Institute for Informatics, Germany

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Motivation:

Optimization [1]
- ✅ Fits input well
- ✅ Represents shapes that are far from the mean
- ❌ Often trapped in local minima
- ❌ Slow

Learning-based [2, 3]
- ✅ Poses are accurate
- ✅ Fast
- ❌ Strong bias towards average body shape

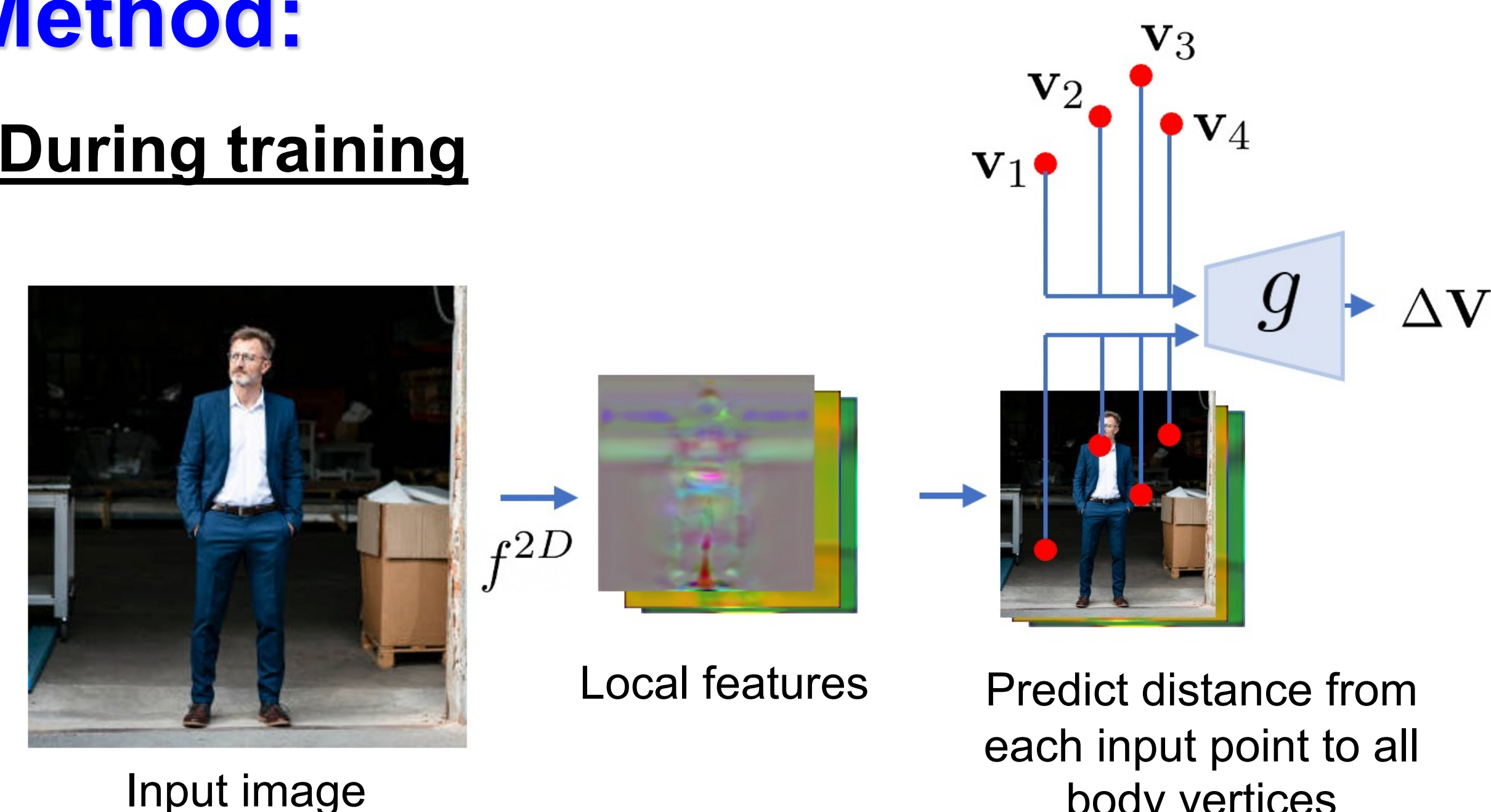## Learned Vertex Descent:

① Novel learning-based optimization where a network predicts vertex direction towards global minima.

② Optimization is **fast**, does not require hand-crafted objective functions, and is **not sensitive to initialization**.

③ State-of-the-art results in body shape estimation from a single image.

④ The proposed formulation can be easily adapted to other domains, achieving state-of-the-art results in body and hand registration given input 3D scans.
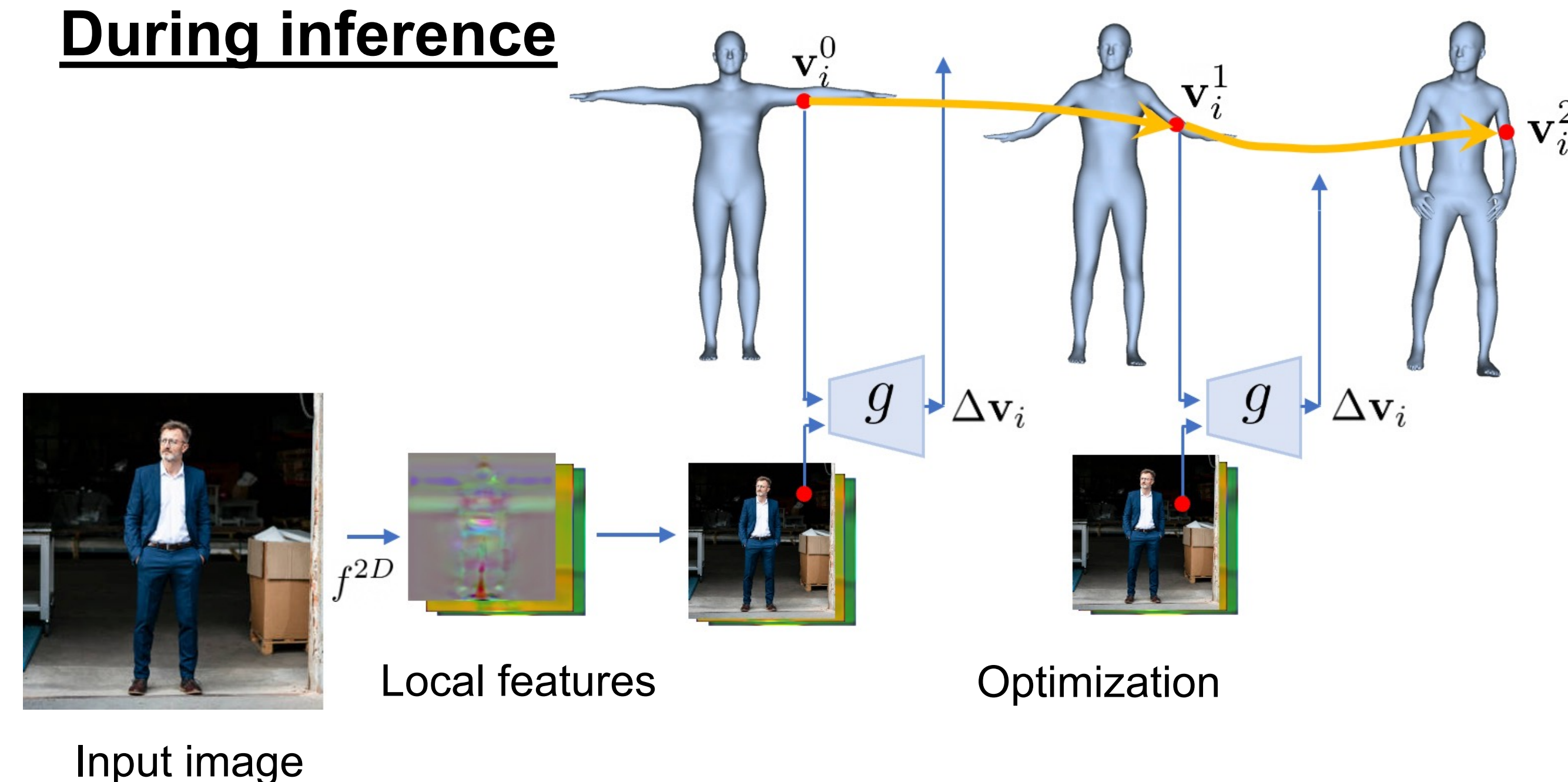
Input image   Initialization   Reconstruction

References:

[1] SMPL-X, CVPR 2019
[2] ExPose, ECCV 2020
[3] ProHMR, ICCV 2021

Method:

During training

$\mathbf{v}_3$
$\mathbf{v}_2$
$\mathbf{v}_4$
$\mathbf{v}_1$

g $\Delta \mathbf{V}$

Input image f^{2D} Local features   Predict distance from each input point to all body vertices

During inference

$\mathbf{v}_i^0$ $\mathbf{v}_i^1$ $\mathbf{v}_i^2$

g $\Delta \mathbf{v}_i$ g $\Delta \mathbf{v}_i$
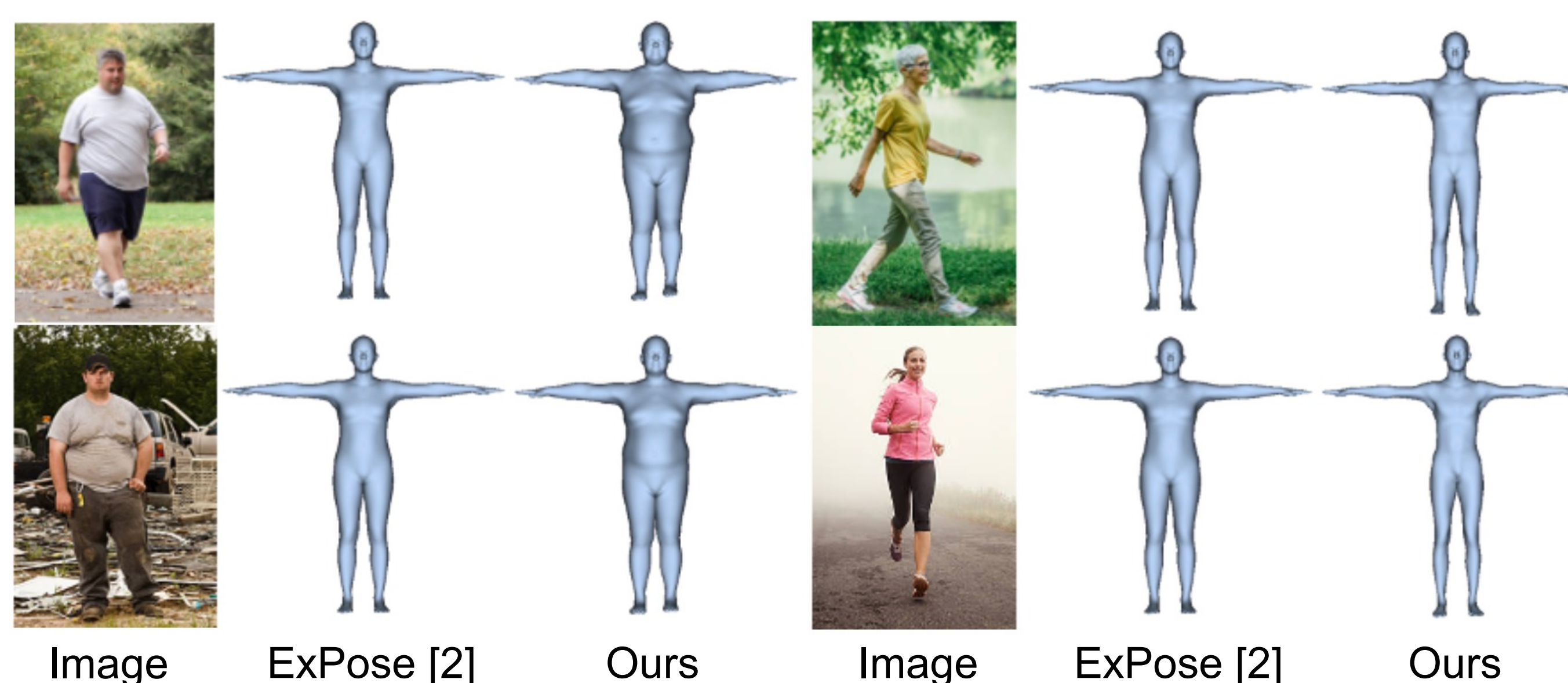
Input image f^{2D} Local features   Optimization

① MLP predicts clipped direction towards global minima

② The use of local features ensures that the 3D reconstruction will be aligned with the input image
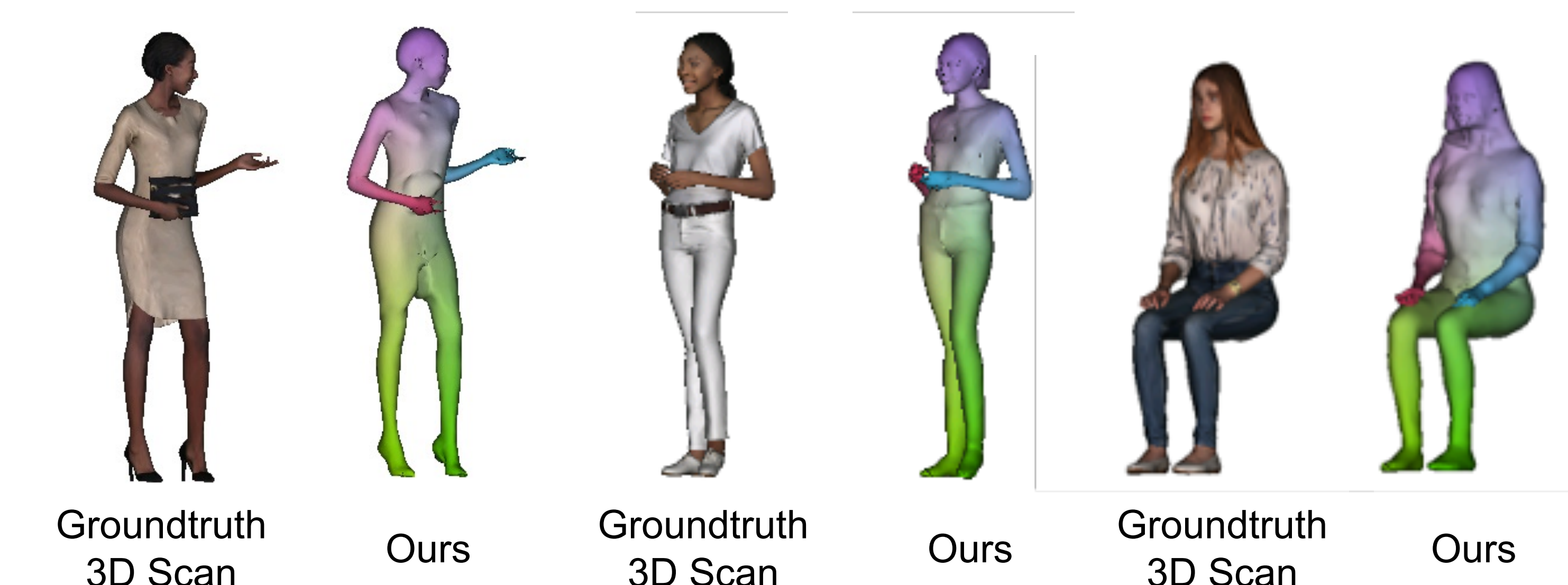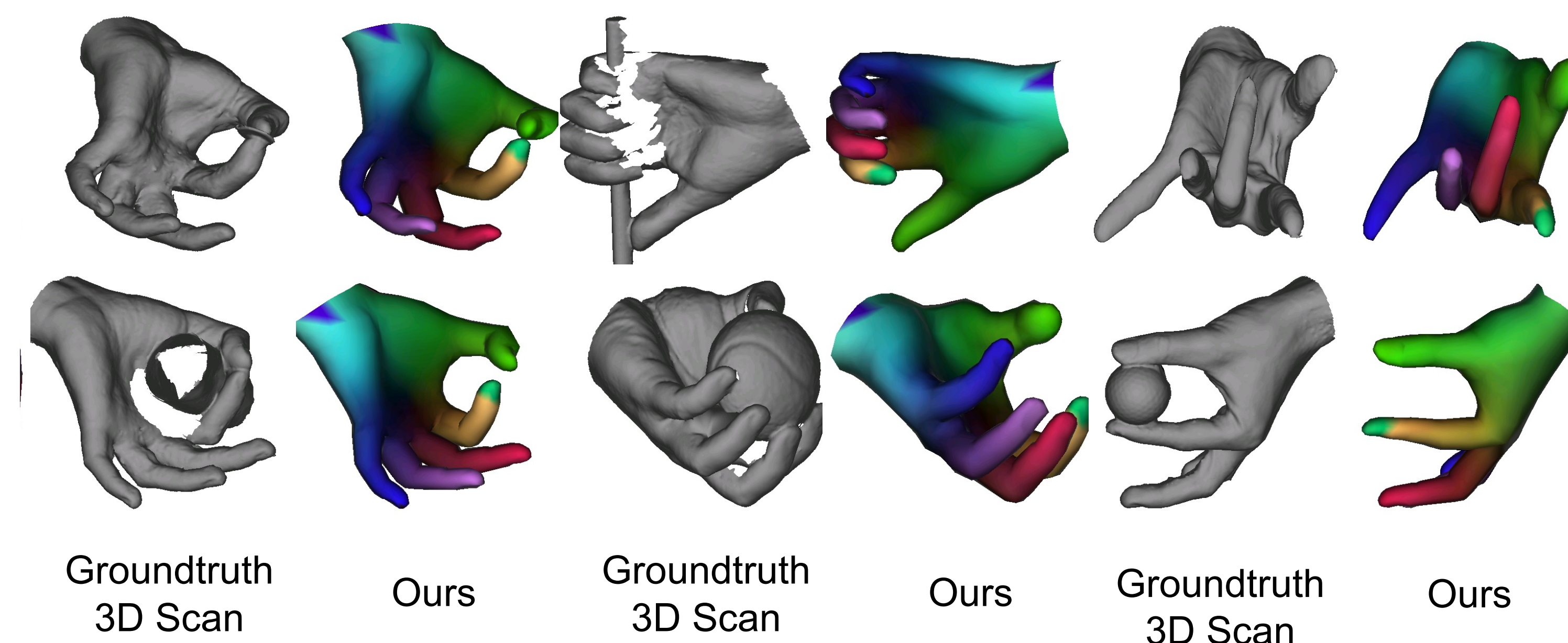
Body shape estimation:

Image   ExPose [2]   Ours   Image   ExPose [2]   Ours

Results:

SMPL estimation from monocular images

Image   Reconstruction   Image   Reconstruction   Image   Reconstruction

Body registration from input point clouds

Groundtruth 3D Scan   Ours   Groundtruth 3D Scan   Ours   Groundtruth 3D Scan   Ours

Hand registration from input point clouds

Groundtruth 3D Scan   Ours   Groundtruth 3D Scan   Ours   Groundtruth 3D Scan   Ours